



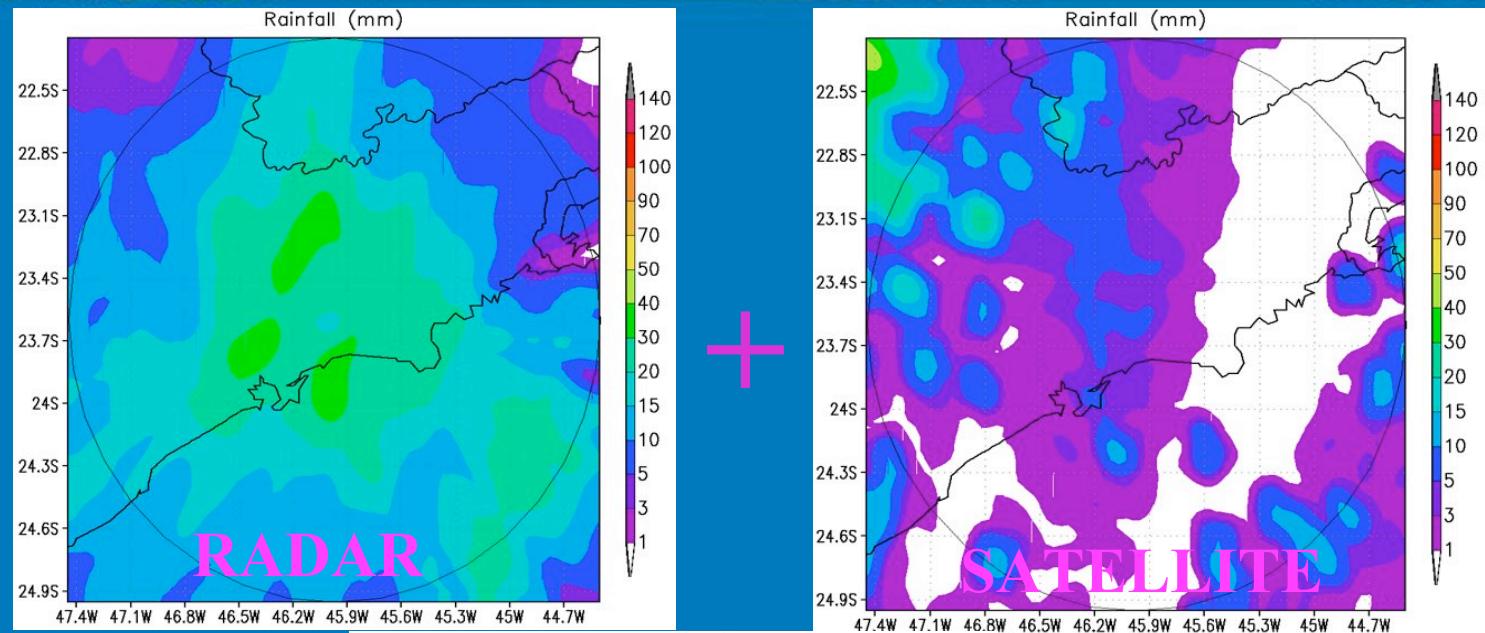
Status of GPM Science and Related Issues in BRAZIL

GPM-Brazil Coordination Committee

Contributions: Augusto José Pereira – IAG/USP
Carlos Morales – IAG/USP
Eduardo Assad – EMBRAPA
Luiz Augusto Machado – CPTEC/INPE
Nelson Arai - AEB
Raimundo Nonato Fialho Mussi – AEB
Reinaldo Bonfim da Silveira – INMET
Roberto Vicente Calheiros – IPMet / UNESP

Presented by: Roberto Vicente Calheiros

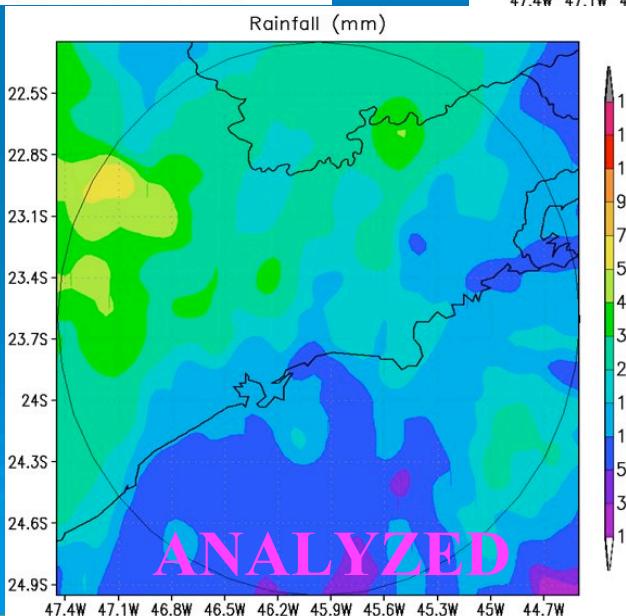
SCIENCE I



SATELLITE – RADAR – RAINGAGE

SOAS – Statistical Objective Analysis Scheme

- Merge satellite, radar and gage 24hour rainfall accumulation.
- Integrate raw radar and raw satellite derived rainfall estimates to raingage. Estimate analysis error and provide the final merged analysis field
- Use both radar & satellite analysed fields.
 - Methodology used minimizes error analysis to values under the lowest of the errors between the two rain estimates based on 1: radar and 2: satellite



Reference:

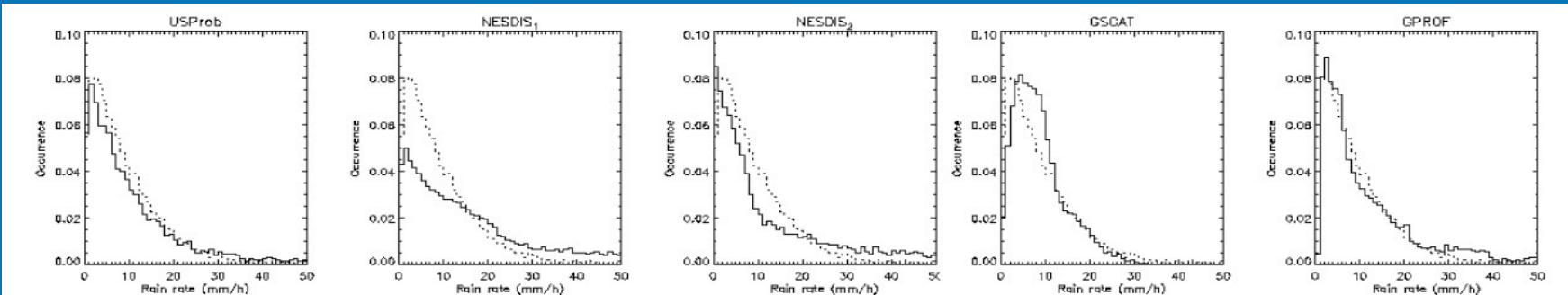
Pereira Filho, A. J., O. Massambani, R. Hallak, H. Karam and R. Haes; "A Hydrological Forecast for the Metropolitan Area of São Paulo". Workshop on Warnings of Real-Time Hazards by Using Nowcasting Technology, Sydney, Australia, 2006, paper 7.23, pp. 6.



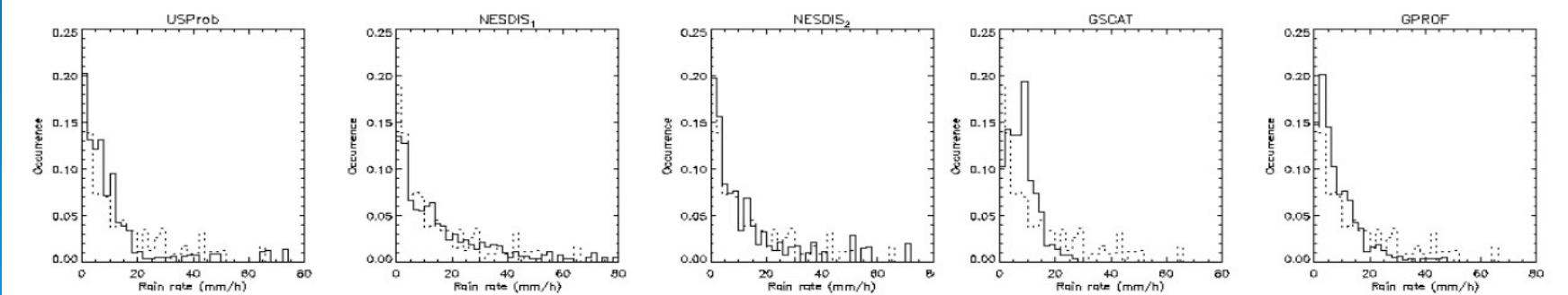
SCIENCE IIa

Precipitation in the Amazon Basin using MW

- . Rain rate distributions from S-POL and PR-TRMM
- . USProb, NESDIS 1 & 2, GSCAT, GPROF runs
- . Rain rates and error distributions:
comparisons of retrievals from algorithms and radars (S-POL & PR)
- . USProb and GPROF in good agreement with PR & S-POL
(but GPROF shows a bi-modal distribution vis-à-vis PR)
- USProb and GSCAT have low mean error values, but GSCAT has a bias exceeding 0.4

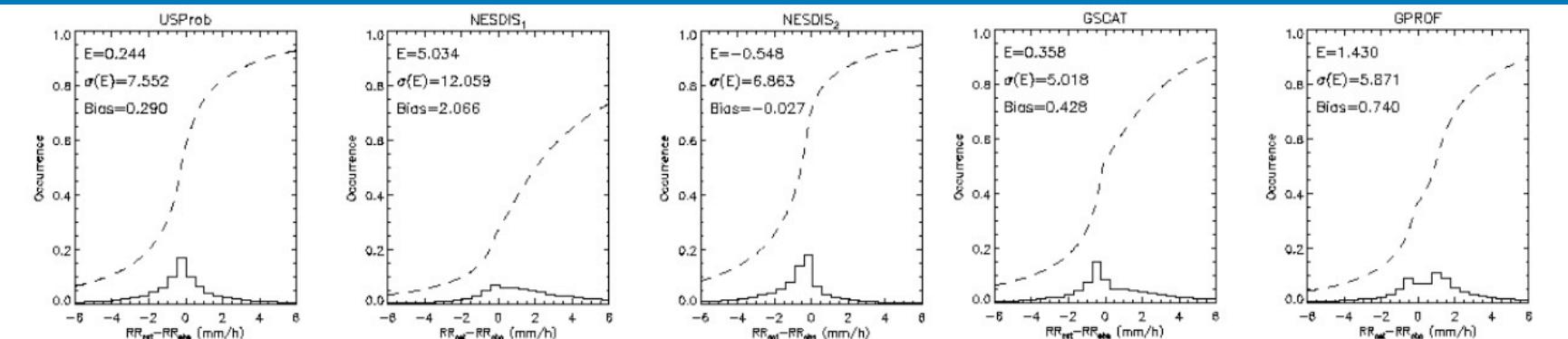


Observed: TRMM/PR, bin size = 1 mm/h

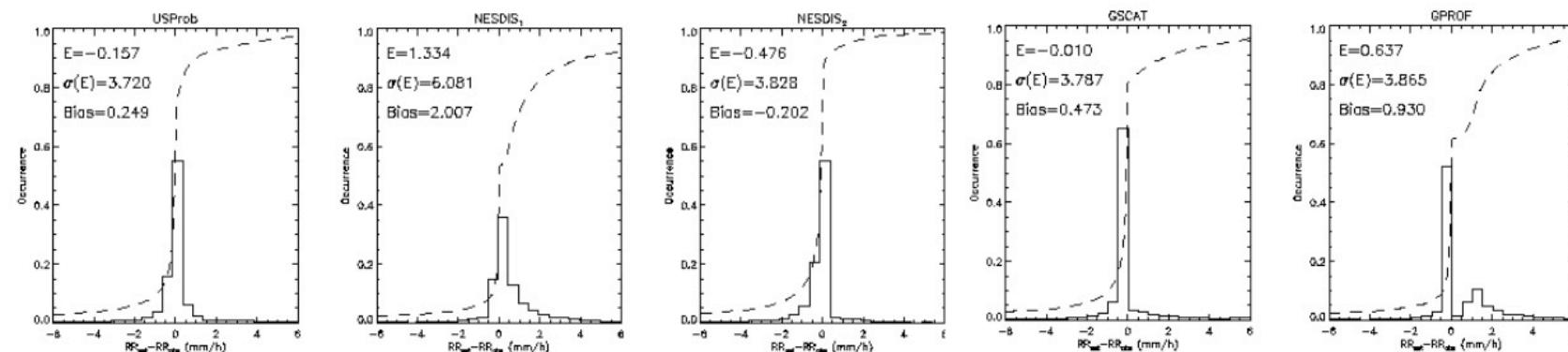


Observed: S-POL, bin size = 2 mm/h

SCIENCE IIb



Observed: TRMM/PR

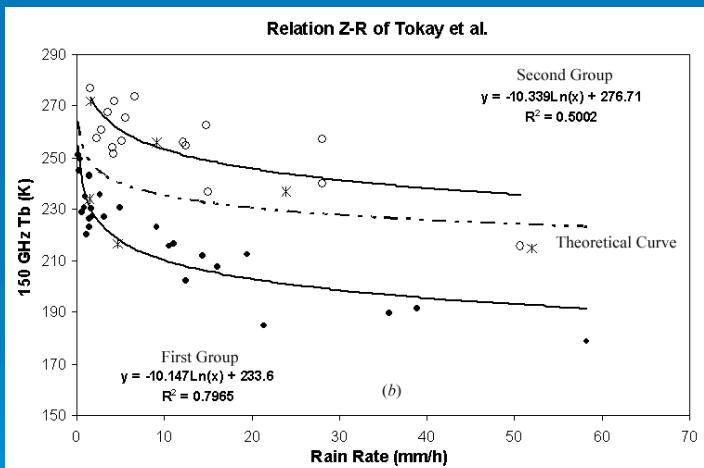
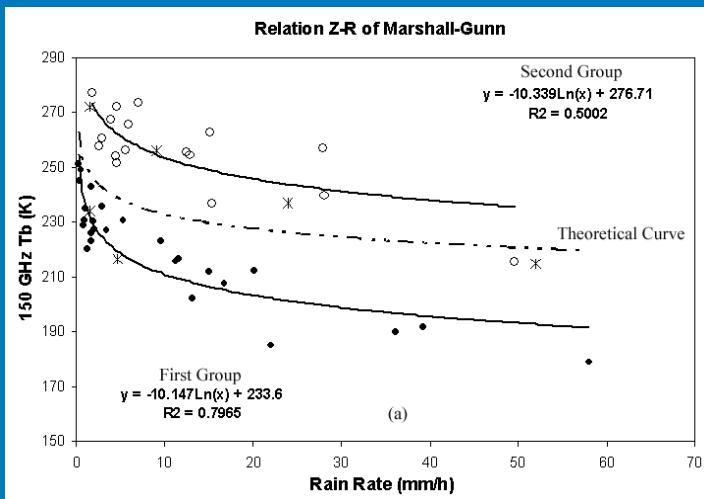


Observed: S-POL

Reference:

BISCARO, T. S. 2006, "Precipitation Estimate via Remote Sensing in MW in the Amazon Basin", MS dissertation (in Portuguese) in Meteorology, IAG (Institute of Astronomy, Geophysics and Atmospheric Science)/USP(University of São Paulo), pp. 113.

SCIENCE III



Reference:

Lima, W. F. A., L. A. T. Machado, C. A. Morales, N. Vitard, 2006, "Rainfall sensibility analysis for the HSB Sounder: an Amazon case study", International Journal of Remote Sensing, in press.

Rainfall Sensitivity for MW Radiometry in the Amazon

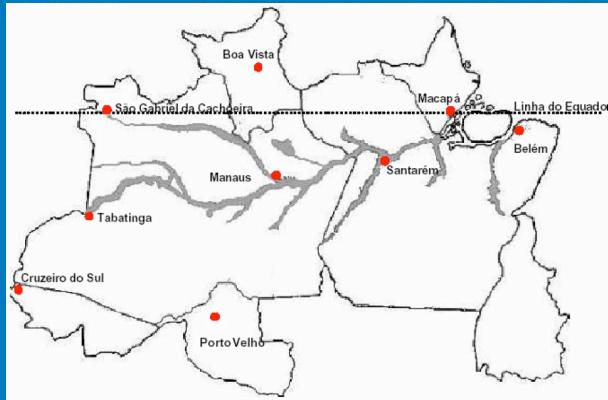
- 1) Data: from HSB (Humidity Sounder for Brazil) and radar, complemented with a few rain gages. There is a data stratification into two groups showing low and high variability, respectively
- 2) Curves are:
 - a) Theoretical using Eddington model, for two Z-R relationships, e.g. Marshall-Gunn and Tokay
 - b) Empirically adjusted, for the two sets of data (low & high variability)

Obs: Star points are raingage measurements

- 3) Verification: there only small changes when using the 2 different Z-R relationships. Knowledge of ice & liquid water distribution is more important when simulating rain in the 150 GHz channel
- 4) Conclusions: based on both theoretical & empirical results it is concluded that the HSB channels respond satisfactorily to the variability of liquid water and precipitation rate mainly in the 150 GHz channel.

SCIENCE IV

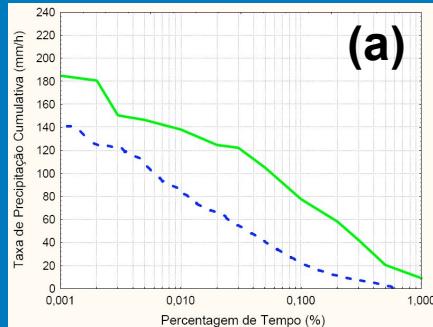
Rain rate distributions in the Amazon



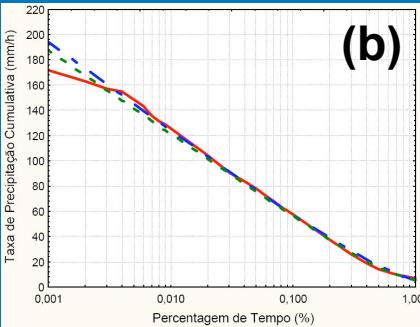
Red dots = measurement sites at the Amazon Region, specific for this study

a) Rain distribution for Boa Vista, annual (dashed line) and month of largest discrepancy (full line).

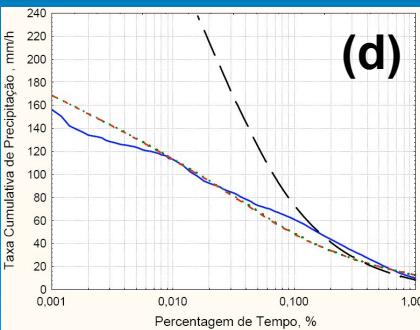
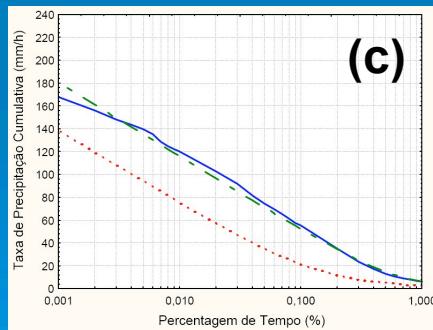
c) Cumulative rain rate distribution for Cruzeiro do Sul (measured, full line) and as modeled through Rec. U.I.T_R P.837-4 with the model meteorological parameters (dashed line) and with the same Rec. U.I.T_R P.837-4 but with the new meteorological parameters (dash-dot line).



b) Cumulative rain rate distribution, as measured at Cruzeiro do Sul (full) and as estimated through Moupfouma (dash-dot) and Salonen-Baptista (dashed) distributions.



d) Cumulative rain rate, for Tabatinga as measured by the gage (full), through radar with probabilistic method (dotted) and through radar with Marshal-Palmer relationships (dashed).



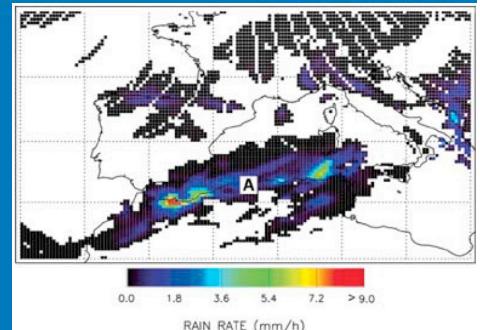
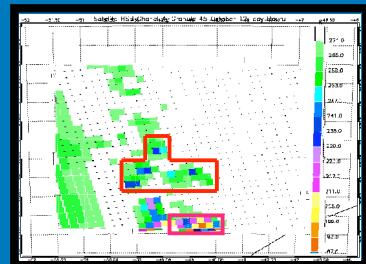
Reference: Cerqueira, J.L.P., 2006, "Radiometeorological Study of the Amazon Region", PhD Thesis (in Portuguese), Graduate Program in Electrical Engineering, PUC – Rio (Catholic University of Rio de Janeiro, p. 224)

MW – radar & MW – IR blend

SCIENCE V

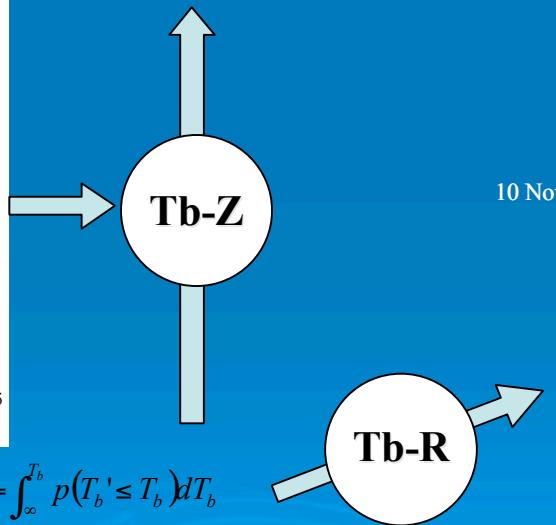
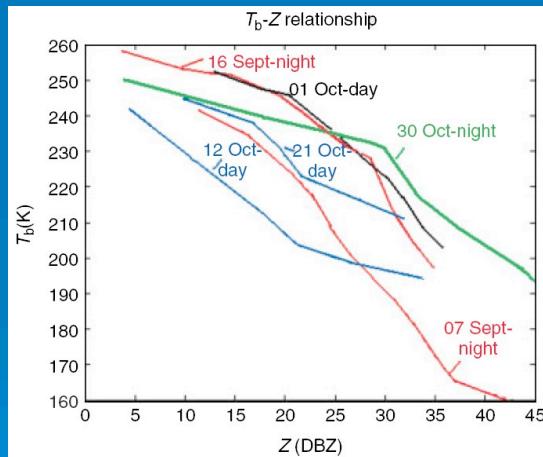
- 1) Relate Satellite Tb to rain rate (radar, model... raingage) by equating probabilities
- 2) Clone radar cells with satellite data to extend radar range
- 3) Assimilate satellite rainfall products into mesoscale models (e.g. for more precise flood forecast and heavy rain events)

Machado, R. and Calheiros, R. V.
“Cloning Radar Cells at Outer Ranges: a Test with the Bauru Radar”. 31st Conference on Radar Meteorology (vol. II), p.843-845, 6-12 August, 2003, Seattle, Washington.



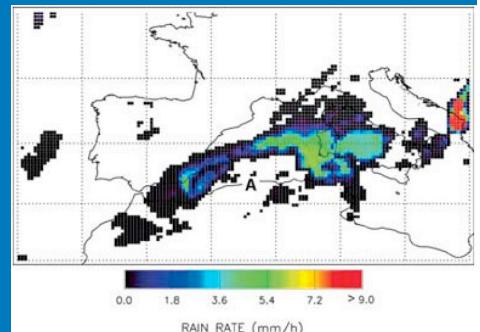
10 November 2001, 0300 UTC. A=Algiers, BOLAM – model.

Obs: Eduart Haruni (McGill/Atmospheric Sciences) is acknowledged for help with figures]

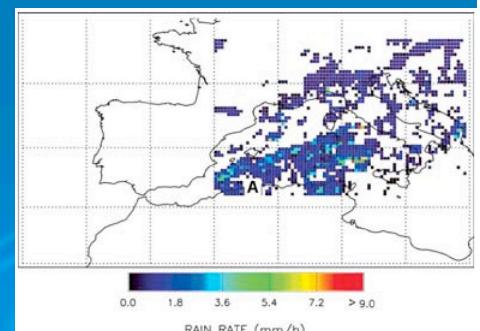


$$\int_z^{\infty} p(Z', R \geq Z, R) dZ, R = \int_{\infty}^{T_b} p(T_b' \leq T_b) dT_b$$

Calheiros, R.V., R. Machado and M.A. Lima, 2005, “Cell detection at far ranges: supporting Tb-Z relationships”, Atmos.Sci.Let, vol 6, Issue 1, p.54-58.



10 November 2001, 0300 UTC. A = Algiers, NRL – combined IR-MW algorithm.

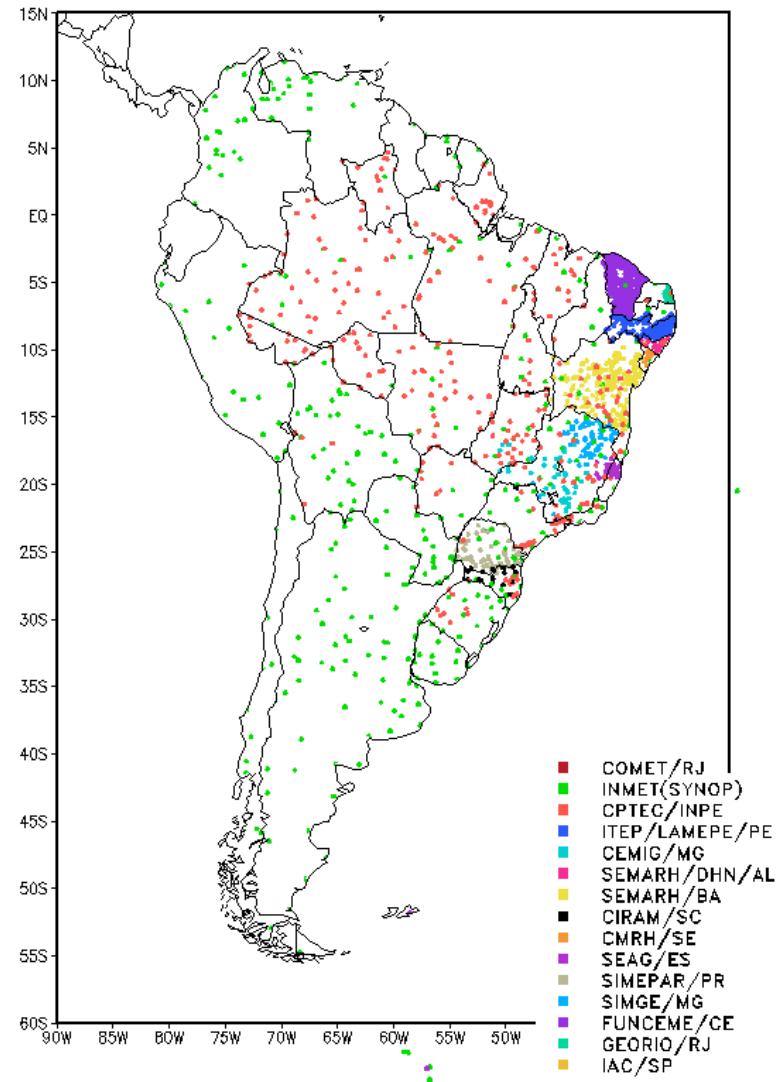


10 November 2001, 0300 UTC. A = Algiers, IRE – IR algorithm.

Kästner, M., Torricella, F. & Davolio, S. “Intercomparison of satellite-based and model-based rainfall analyses”. Meteorol. Appl. 13, 213-223, 2006.



VALIDATION I

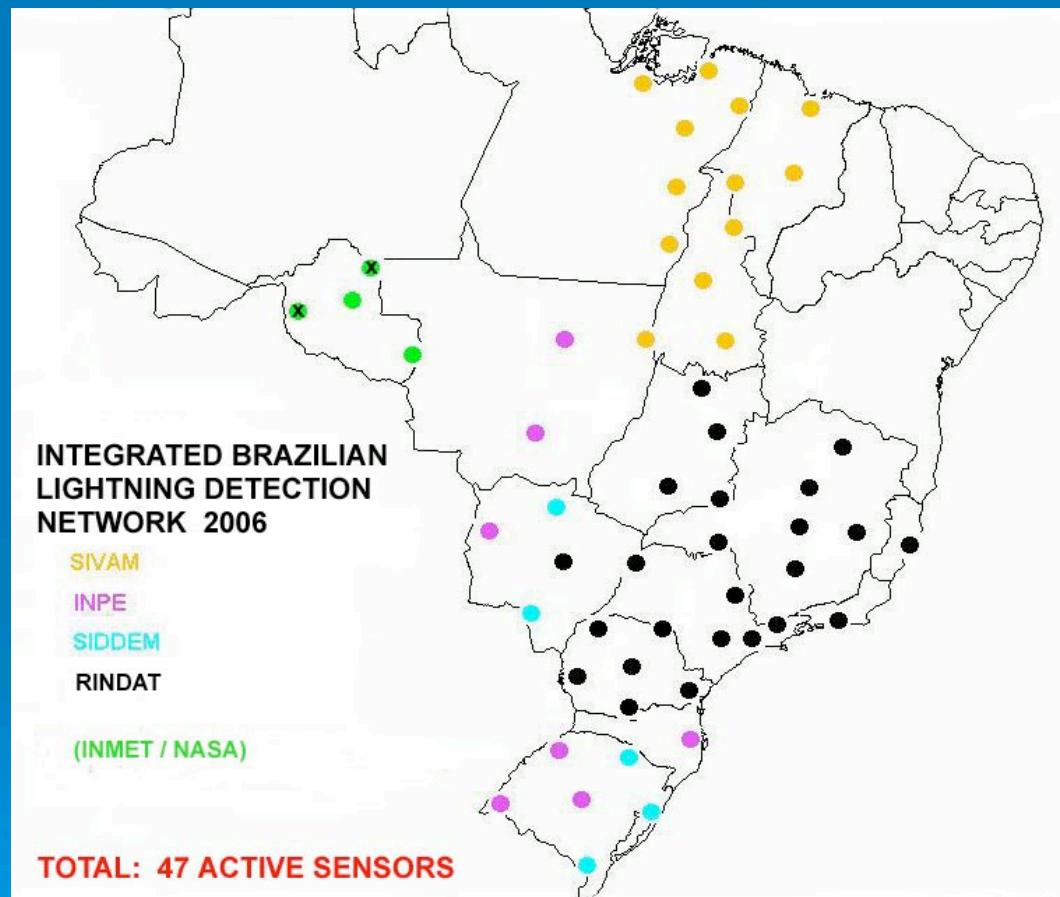


Raingage Networks providing data to CPTEC, as of October, 2006.

Green dots are SYNOP stations, which are assimilated in the models (data assimilated are daily totals). They are received at CPTEC at every 3-hour period. All other plotted stations are used in weather and climate studies. There is a number of stations (not represented in the map) from which data is obtained by CPTEC through the respective institutional page in the internet.

VALIDATION II

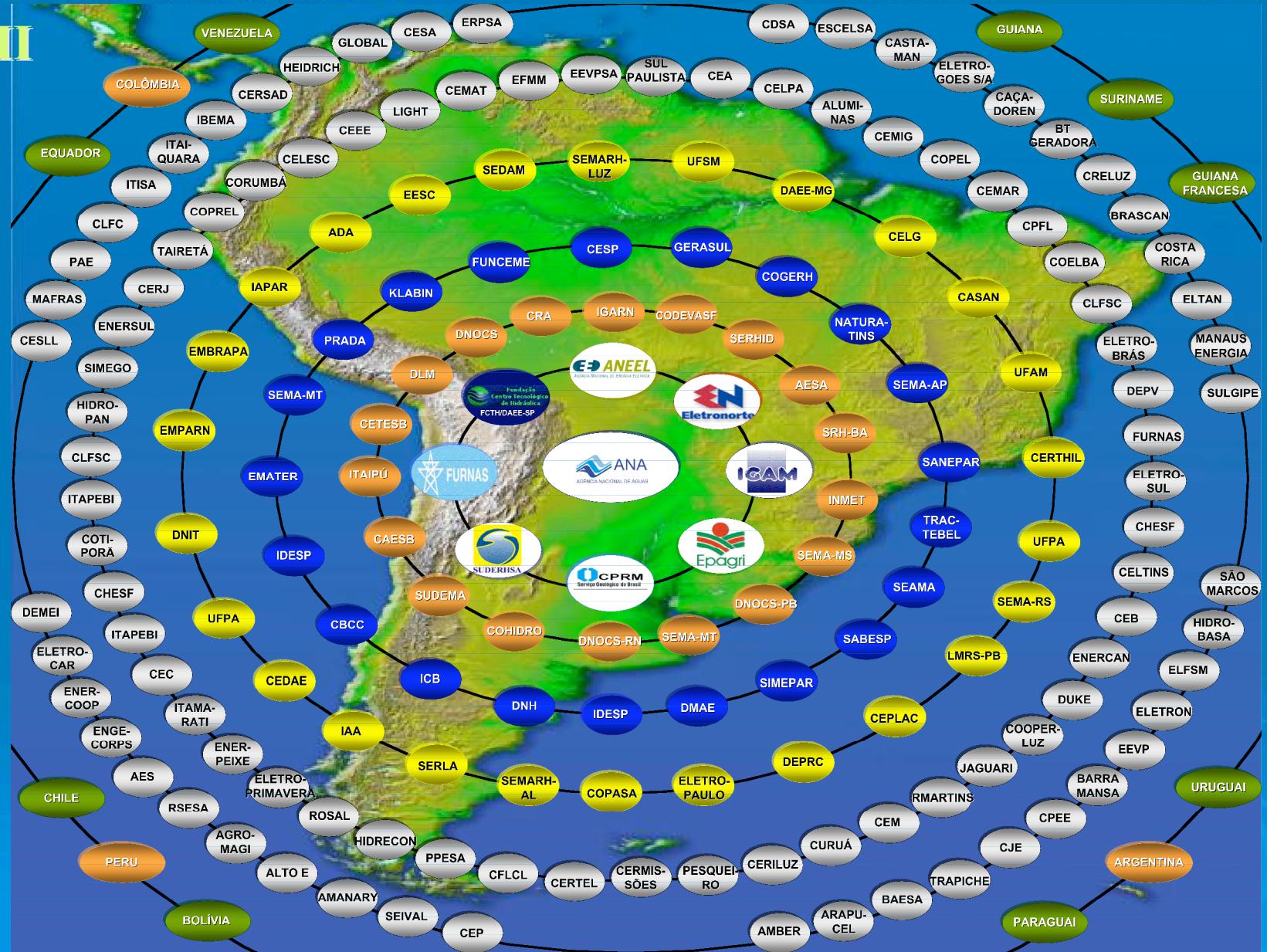
Brazilian Lightning Detection Network 2006



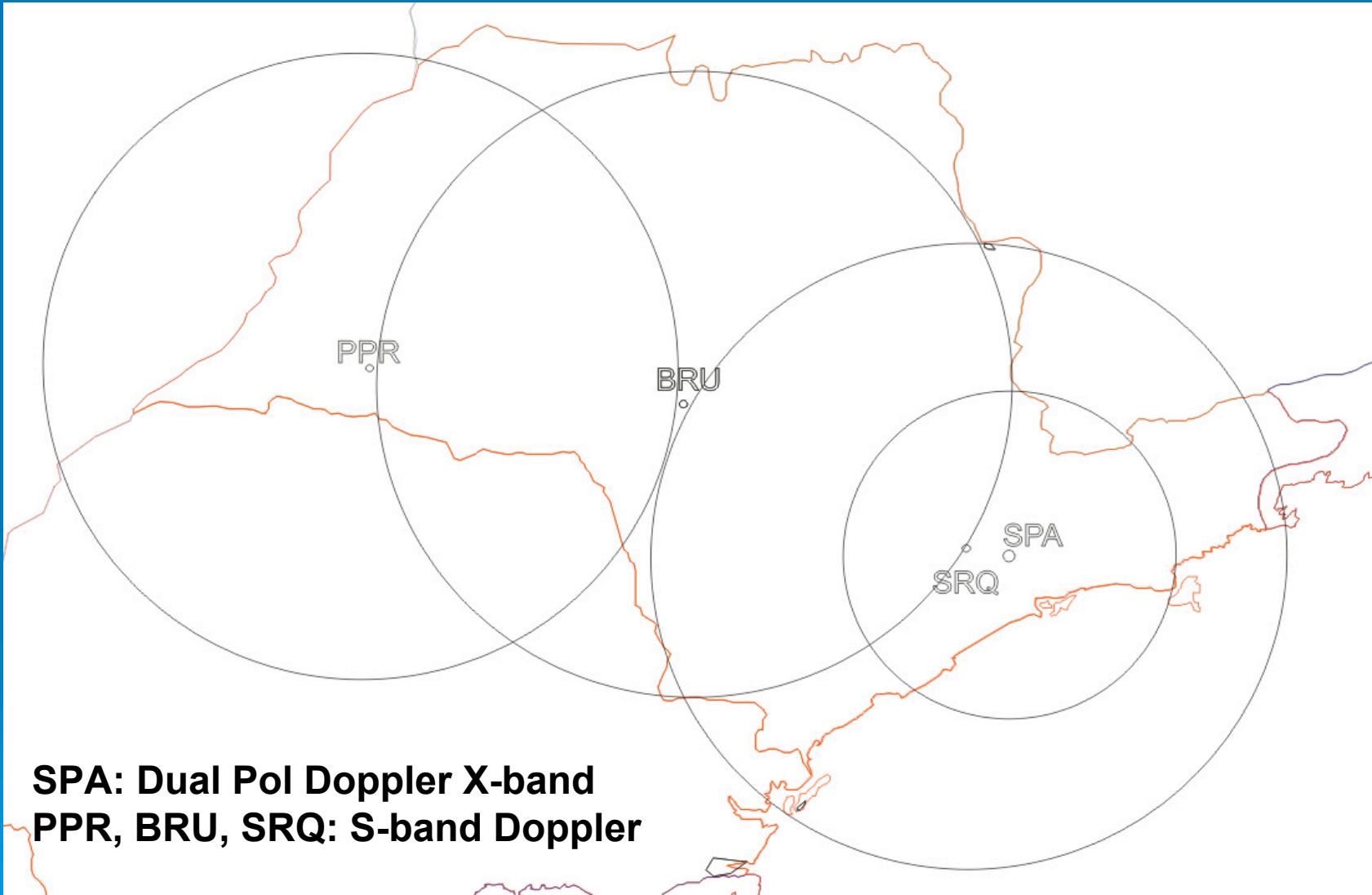
Currently comprising a total of 47 sensors, all of them integrated by INPE (BrasilDAT), and covering a total of 70% of Brazil, excluding the Amazonia region.

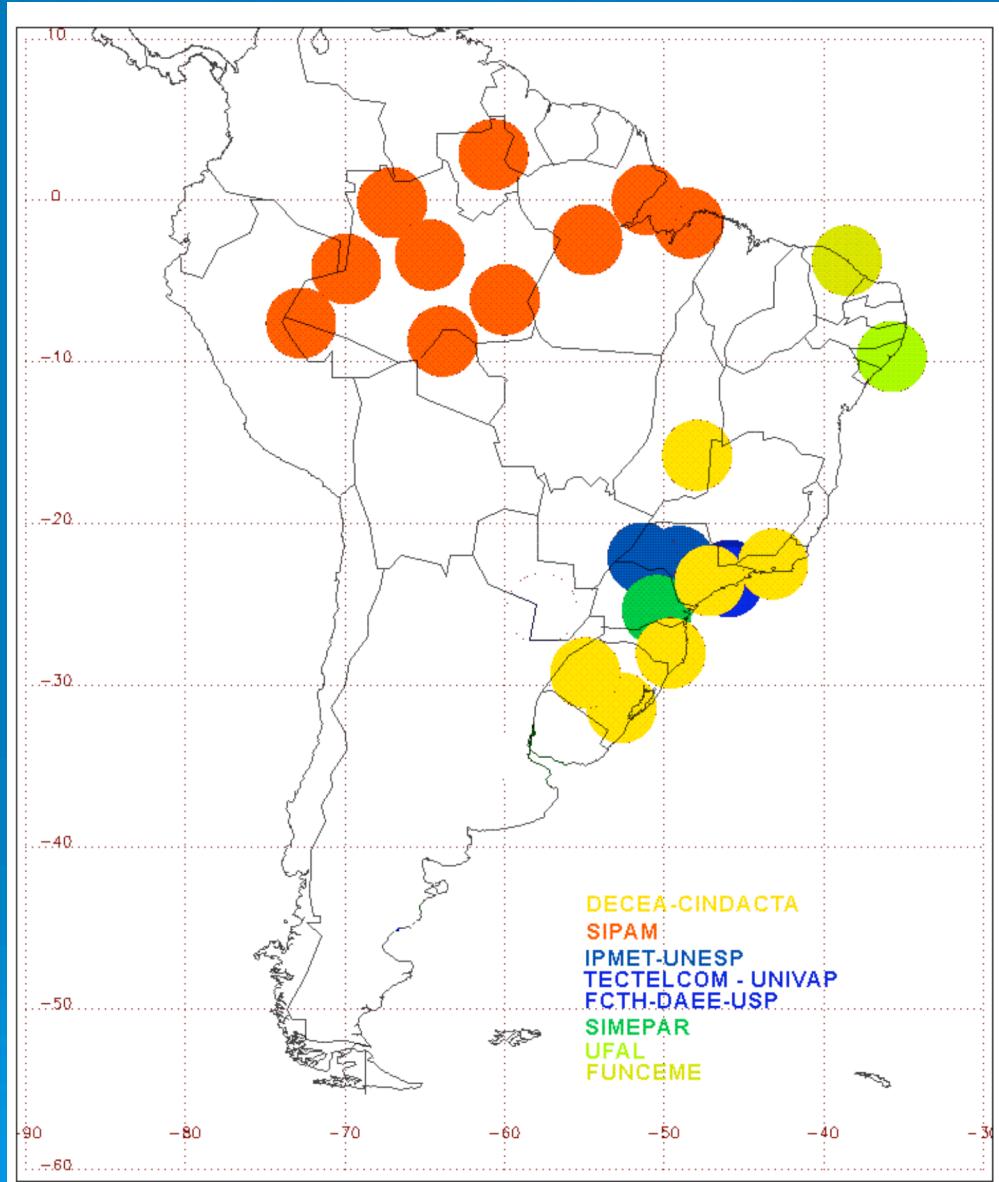
During the next 2 years the addition of 15 sensors has already been approved.

V. III



VALIDATION IV





VALIDATION V

Operational radars in Brazil:

19 - Doppler S-Band

1 - S-Band (non-coherent)

1 - C-Band (non-coherent)

1 - Doppler X-Band

Updated : October, 2006

Indicated range: 240 km